MULTIMEDIA UNIVERSITY ™

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

EEL3036 – POWER SYSTEM ANALYSIS

(LE)

25 OCTOBER 2019
9 AM – 11 AM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 pages including the cover page with 4 Questions only.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. For each calculation step, keep and round up to FOUR decimal places.

Question 1

(a) Power system is a network components designed to efficiently transmit and distribute energy produced by the generators to the consumer ends. List out the **FIVE** major components of a power system. [5 Marks]

(b) A single phase 9.5 kVA, 500/1500 V transformer has an impedance of 1.325 Ω with respect to primary side. Determine the per-unit impedance with respect to primary and secondary sides. What is the conclusion that can be drawn from the calculated per-unit impedance values? [7 Marks]

(c) The one-line diagram of a power system is shown in Figure Q1(c).

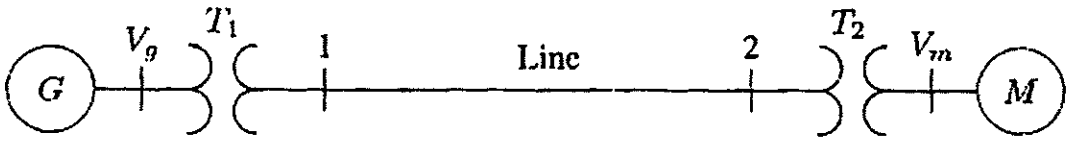

Figure Q1(c)

The three-phase power and line ratings are given below. Draw the per phase impedance diagram by showing all impedances in per-unit on a 100 MVA base. Choose 20 kV as the voltage base for the generator. [13 Marks]

G : 60 MVA	20 kV	$x = 9\%$
T_1 : 50 MVA	20/200 kV	$x = 10\ \%$
T_2 : 50 MVA	200/20 kV	$x = 10\ \%$
M : 43.2 MVA	18 kV	$x = 8\%$
Line :	200 kV	$Z = 120 + j200\ \Omega$

Question 2

(a) Figure Q2(a) shows the single line diagram of a three-bus power system with generation at buses 1 and 3. The voltage at bus 1 is $V_1 = 1.025\angle 0°$ per unit. Voltage magnitude at bus 3 is fixed at 1.03 per-unit with a real power generation of 300 MW. A load consisting of 400 MW and 200 Mvar is taken from bus 2. Line impedances are given in per-unit on a 100 MVA base.

(i) Form the Y_{BUS} matrix. [2 Marks]

(ii) Using Gauss-Seidel method, determine the phasor values of V_2 and V_3 at the end of the first iteration. Line resistances and line charging susceptances are neglected. [12 Marks]

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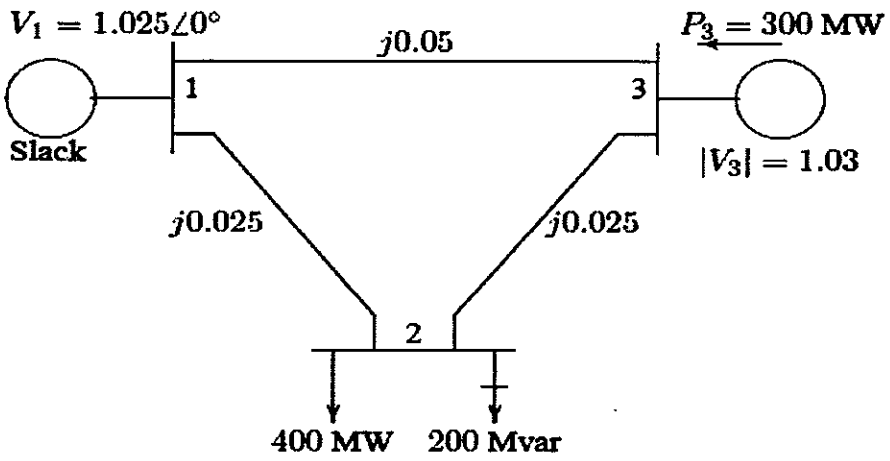

Figure Q2(a)

(b) Figure Q2(b) shows the one-line diagram of a three-bus power system with generation at bus 1. All the data is as marked on the diagram. Line impedances are marked in per-unit on 100 MVA base. For the purpose of hand calculations, line resistance and line charging susceptances are neglected.

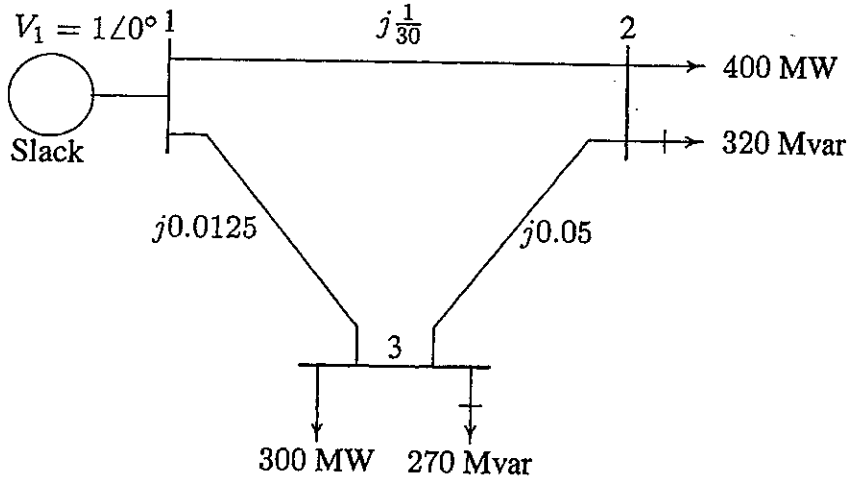

Figure Q2(b)

The Y_{BUS} matrix is given as below:

$$Y_{BUS} = \begin{bmatrix} -j110 & j30 & j80 \\ j30 & -j50 & j20 \\ j80 & j20 & -j100 \end{bmatrix}$$

Assuming that all the angle corrections of $\Delta\delta_2$ and $\Delta\delta_3$ are zero degrees.

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(i) Determine the change in real and reactive powers at bus 2 (ΔP_2) and bus 3 (ΔQ_3), respectively. [3 Marks]

(ii) Calculate the Jacobian matrix coefficients of $\frac{\partial P_2}{\partial \delta_2}$ and $\frac{\partial Q_3}{\partial |V_3|}$ that will be used in the Newton-Raphson power solution. [5 Marks]

(iii) Calculate the reactive mismatches of $\frac{\Delta Q_2}{|V_2|}$ and $\frac{\Delta Q_3}{|V_3|}$. [3 Marks]

Question 3

(a) Define the terms symmetrical and unsymmetrical faults and list five different types of faults categorizing them with the terms. [7 Marks]

(b) Figure Q3(b) shows an 11 kV distribution system fed from a grid source, two generators and the grid with voltage source 132 kV are stepped down to 11 kV through transformers. Three-phase fault level at bus 1 is 4000 MVA. Network parameters are as shown in Figure Q3(b) and choose a base of 100 MVA for this section.

(i) Draw the impedance network of the distribution system shown in Figure Q3(b). Shows all the impedance values. [9 Marks]

(ii) Determine the fault current, if a three-phase balanced fault with fault impedance, $Z_j = j0.1$ per-unit accounts at Bus 4. Assume pre-fault voltage is 1 per-unit. [9 Marks]

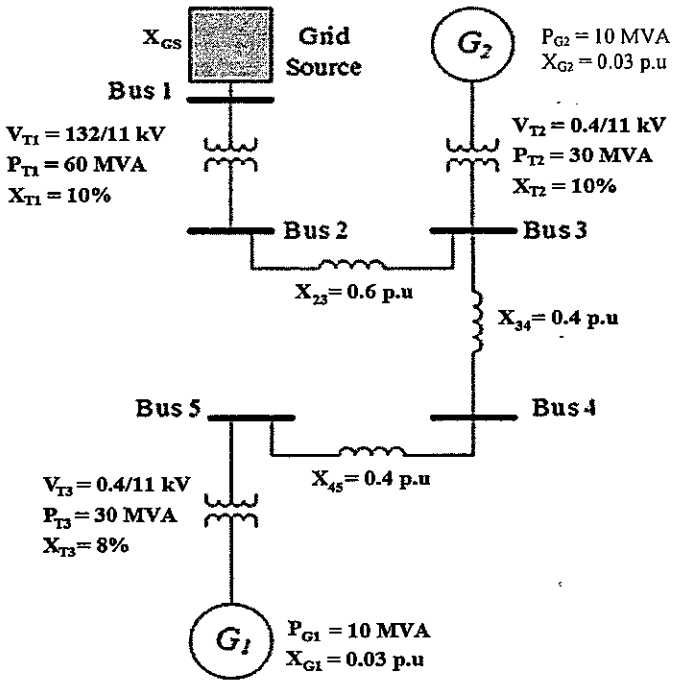

Figure Q3(b)

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Question 4

A generator operating at 50 Hz delivered 1.0 per-unit power to an infinite bus through a transmission circuit in which resistance is ignored. A fault takes place reducing the maximum power transferable to 0.5 per-unit whereas before the fault this power was 2.0 per-unit and after the clearance of fault it is 1.5 per-unit.

(a) By the use of equal area criterion, determine the critical clearing angle.

[15 Marks]

(b) Draw the swing curve plot of pre-fault, during-fault and post-fault and shade both equal areas. Also use the values obtained from Part 4(a) and label them correctly in the drawn figure. [6 Marks]

(c) Name two methods of transient stability analysis in power system. [4 Marks]

End of Paper.